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Link capacity adjustment scheme (LCAS) for virtual concatenated signals

ITU-T Recommendation G.7042/Y.1305

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ITU-T Recommendation G.7042/Y.1305

Link capacity adjustment scheme (LCAS) for virtual concatenated signals

Summary

This Recommendation defines the methodology that should be used to change the bandwidth capacity of a Virtual Concatenated signal defined for and used by transport networks (i.e. SDH and OTN).

Source

ITU-T Recommendation G.7042/Y.1305 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

Document history	
Issue	Notes
0.0 proposal	Initial proposal, August 2001

Keywords

Virtual Concatenation, Link Capacity Adjustment Scheme, Synchronous Digital Hierarchy, Optical Transport Network.

FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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CONTENTS

ITU-T Recommendation G.7042/Y.1305

Link capacity adjustment scheme (LCAS) for virtual concatenated signals

1 Scope

This Recommendation specifies a link capacity adjustment scheme that should be used to increase or decrease the capacity of a container that is transported in an SDH/OTN network using Virtual Concatenation. In addition, the scheme will automatically decrease the capacity if a member experiences a failure in the network, and increase the capacity when the network fault is repaired. The scheme is applicable to every member of the Virtual Concatenation group.

This Recommendation defines the required states at the source and at the sink side of the link as well as the control information exchanged between both the source and the sink side of the link to enable the flexible resizing of this Virtual Concatenated signal. The actual information fields used to convey the control information through the transport network are defined in their respective Recommendations ITU-T Recs. G.707 [1] and G.783 [3] for SDH and ITU-T Recs. G.709 [2] and G.798 [4] for OTN.

2 References

The following ITU-T Recommendations, and other references contain provisions which through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation G.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy SDH.*

[2] ITU-T Recommendation G.709/Y.1331 (2001), *Network node interface for the optical transport network (OTN)*.

[3] ITU-T Recommendation G.783 (2000), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.

[4] ITU-T Recommendation G.798 (2002), *Characteristics of optical transport network hierarchy equipment functional blocks*.

[5] ITU-T Recommendation G.806 (2000), *Characteristics of transport equipment – Description methodology and generic functionality*.

[6] ITU-T Recommendation Z.100 (1999), *Specification and description language (SDL).*

3 Terms and definitions

This Recommendation defines the following terms:

3.1 link: a connection though a network from termination function to termination function, this can be related to the members of a virtual concatenation group as well as the virtual concatenation group itself.

3.2 member: an individual server layer container that belongs to a virtual concatenated group.

3.3 virtual concatenation group (VCG): a group of co-located member trail termination functions that are connected to the same virtual concatenation link.

4 Abbreviations

This Recommendation uses the following abbreviations:

CRC	Cyclic Redundancy Check
CTRL	Control word sent from source to sink
DNU	Do Not Use
EOS	End of Sequence
GID	Group Identification
LCAS	Link Capacity Adjustment Scheme
LOM	Loss of Multiframe
MFI	MultiFrame Indicator
MST	Member Status
NORM	Normal Operating Mode
RS-Ack	Re-Sequence Acknowledge
Sk	Sink
So	Source
SQ	Sequence Indicator
TSD	Trail Signal Degrade
TSF	Trail Signal Fail
VCG	Virtual Concatenation Group

5 Conventions

The order of transmission of information in all the diagrams in this Recommendation is first from left to right, and then from top to bottom. Within each byte the most significant bit is transmitted first. The most significant bit (bit 1) is shown at the left in all the diagrams.

6 LCAS for virtual concatenation

6.1 Methodology

LCAS in the virtual concatenation source and sink adaptation functions provides a control mechanism to hitless increase or decrease the capacity of a VCG link to meet the bandwidth needs of the application. It also provides the capability of temporarily removing member links that have experienced a failure. The LCAS assumes that in cases of capacity initiation, increase or decrease, the construction or destruction of the end-to-end path of each individual member is the responsibility of the Network and Element Management Systems.

6.2 Control packet

Synchronization of changes in the capacity of the transmitter (So) and the receiver (Sk) shall be achieved by a control packet. Each control packet describes the state of the link during the *next* control packet. Changes are sent in advance so that the receiver can switch to the new configuration as soon as it arrives.

The control packet consists of fields dedicated to a specific function. The control packet contains information sent from So to Sk and information sent from Sk to So, see also Figure 1.

Forward direction, So to Sk:

- MultiFrame Indicator (MFI) field;
- Sequence Indicator (SQ) field;
- Control (CTRL) field;
- Group Identification (GID) bit.

Return direction, Sk to So:

- Member Status (MST) field;
- Re-Sequence Acknowledge (RS-Ack) bit.

NOTE – MST and RS-Ack are identical in the controlwords of all members of the VCG.

Both directions:

- CRC field;
- Unused bits are reserved and shall be set to "0".

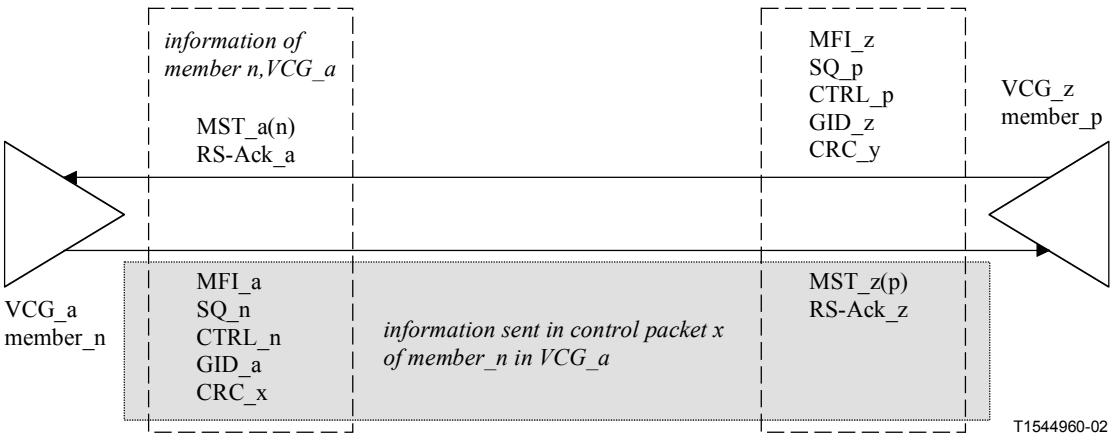


Figure 1/G.7042/Y.1305 – Allocation of information in a control packet

6.2.1 MultiFrame Indicator (MFI) field

At the So side the MFI is equal for all members of the VCG and it will be incremented each frame. At the Sk side the MFI shall be used to realign the payload for all the members in the group. The MFI is used to determine the differential delay between members of the same VCG.

6.2.2 Sequence Indicator (SQ) field

Contains the sequence number assigned to a specific member. Each member of the same VCG is assigned a unique sequence number, starting at 0, similar to the Recommendations for Virtual Concatenation in ITU-T Recs. G.707 [1] and G.709 [2].

At initiation of a VCG source all member SQ shall be set to the highest possible value.

6.2.3 Control (CTRL) field

The control field is used to transfer information from So to Sk. It shall be used to synchronize the Sk with the So and provides the status of the individual member of the group.

Table 1/G.7042/Y.1305 – LCAS CTRL words

Value msb…lsb	Command	Remarks
0000	FIXED	This is an indication that this end uses fixed bandwidth (non-LCAS mode)
0001	ADD	This member is about to be added to the group
0010	NORM	Normal transmission
0011	EOS	End of Sequence indication and Normal transmission
0101	IDLE	This member is not part of the group or about to be removed
1111	DNU	Do Not Use (the payload) the Sk side reported FAIL status

At initiation of a VCG source all members shall send CTRL = IDLE.

6.2.4 Group Identification (GID) bit

Used for identification of the VCG. The GID bit of all members of the same VCG has the same value in the frames with the same MFI.

The GID provides the receiver with a means of verifying that all the arriving members originated from one transmitter. The contents are pseudo-random, but the receiver is not required to synchronize with the incoming stream. The pseudo-random pattern used is $2^{15}-1$.

NOTE – The GID is not valid for members sending the IDLE control word.

6.2.5 CRC field

To simplify the validation of the changes in the virtual concatenation overhead, a CRC is used to protect each control packet. The CRC check is performed on every control packet after it has been received, and the contents rejected if the test fails. If the control packet passes the CRC test, then its contents are used immediately.

6.2.6 Member Status (MST) field

Information from Sk to So about the status of all members of the same VCG.

It reports the member status from Sk to So with two states: OK or FAIL (1 status bit per member). OK = 0, FAIL = 1.

The quantity of members in the VCG can be any number in the allocated range (e.g. 0-255 for High Order in SDH), and can be changed. For each member, the Sk uses the SQ number assigned to it by the So at the MST number for its response to the So. In this manner, the MST values received by the So will always correspond directly to the SQ values that it assigned.

NOTE – In the non-LCAS mode, the receiver function is provisioned to expect a fixed number of members.

To allow the receiver to determine the number of members in the VCG, the highest numbered member is indicated by the use of a last (EOS) value in the control word. All other members have a normal (NORM) or do-not-use (DNU) value in the control word, see Table 1.

At initiation of a VCG sink all members shall report MST = FAIL, all unused MST shall be set to FAIL.

6.2.7 Re-Sequence Acknowledge (RS-Ack) bit

Any changes detected at the Sk regarding the member sequence numbers is reported to the So per VCG by toggling (i.e. change from '0' to '1' or from '1' to '0') the RS-Ack bit, i.e. the RS-Ack bit can only be toggled after the status of all members of the VCG has been evaluated. The toggling of the RS-Ack bit will validate the MST in the preceding multiframe. The So can use this toggling as

an indication that the change initiated by the So has been accepted, and will start accepting new MST information.

6.3 Addition of member(s)

When a member is added it shall always be assigned a sequence number greater than the currently highest sequence number that has EOS in the CTRL code.

Following an ADD command the first member to respond with MST = OK shall be allocated the next highest sequence number and shall change its CTRL code to EOS coinciding with the currently highest member changing its CTRL code to NORM.

NOTE – When the CTRL = ADD is sent to initiate the addition of a new member, it shall be sent continuously until the MST = OK is received.

In case more than one member (e.g. x) is being added, and MST = OK is being simultaneously received for more than one member, then the allocation of sequence indicators is arbitrary provided they are the next x sequence numbers after the currently highest sequence number. The CTRL code for the currently highest member will change from EOS to NORM coinciding with the highest new member's CTRL code being changed to EOS. All other new member's CTRL codes will be set to NORM.

6.3.1 Addition of member(s) payload

The final step for adding a member is to send a NORM or EOS in the control word of the virtual concatenation overhead control packet for that member. The first container frame to contain payload data for the new member shall be the container frame immediately following the container frame that contained the last bit(s) (i.e. the CRC) of the control packet with NORM/EOS message for that member.

6.4 Temporary removal of member

When a member sending a NORM or EOS experiences a failure in the Network this is detected at the Sk (aTSF, aTSD, dLOM) the Sk will send in the MST of that particular member the status FAIL. The So will then either replace the NORM condition by an DNU condition, or replace the EOS condition with an DNU condition and the preceding member will send EOS in the CTRL field.

When the defect causing the temporary removal is cleared this is detected at the Sk. The Sk will send in the MST of that particular member the status OK. The So will then either replace the DNU condition by an NORM condition, or replace the DNU condition with an EOS condition and the preceding member will send NORM in the CTRL field.

6.4.1 Temporary removal of member payload

The final step for temporary removal of a member is to remove the payload area of that particular member from the VCG. The last container frame that contains payload of the removed member shall be the container frame containing the last bit(s) of the control packet containing the first DNU control word. The following container frames will contain all ZEROes in the payload area. Upon reception at the Sk of the DNU control word the payload of this particular member shall not be used to reconstruct the original VCG payload.

The final step after recovering from a temporary removal is to start using the payload area of that member again. The first container frame to contain payload data for the member shall be the container frame immediately following the container frame that contained the last bit(s) of the control packet containing the first NORM or EOS control word for that member.

6.5 Deletion of member(s)

When members are deleted, the sequence numbers and corresponding member status number of the other members shall be renumbered. If the deleted member contains the highest sequence number of that group, the member containing the next highest sequence number shall change its control word to EOS in its control packet coinciding with the deleted member' s control packet with the IDLE control word. If the member deletion occurs somewhere other than at the highest end of the sequence, then the other members with sequence numbers between the newly deleted member and the highest sequence number shall update their sequence indicators in their control packets coinciding with the control packet changing the status of the deleted member.

6.5.1 Deletion of member(s) payload

When a member is deleted by sending an IDLE control word in the control packet on the virtual concatenation overhead for that member, the last container frame in which the deleted member contains payload data shall be the container frame containing the last bit(s) of the control packet containing the IDLE control word.

6.6 LCAS to non-LCAS interworking

Inter-working between non-LCAS and LCAS Virtual Concatenation can be achieved as described in 6.6.1 and 6.6.2. Changes to the number of members in the VCG will be possible only by provisioning.

6.6.1 LCAS transmitter and non-LCAS receiver

An LCAS transmitter can inter-work with a non-LCAS receiver in non-LCAS mode without any special consideration. The LCAS transmitter will place the MFI and SQ as designated in ITU-T Recs. G.707 [1] and G.709 [2]. The receiver will ignore all other bits, i.e. the LCAS overhead information.

The member status returned from sink to source will always be MST = OK.

6.6.2 Non-LCAS transmitter and LCAS receiver

An LCAS receiver expects a CTRL word that is not '0000' and a correct CRC. A non-LCAS transmitter will transmit '0000' in the LCAS CTRL field as well as the CRC field. Therefore when an LCAS receiver is interworking with a non-LCAS transmitter and receives both CTRL word AND CRC equal to '0000', it shall:

- Ignore all information (except MFI and SQ);
- Use MFI and SQ defect detection as defined for virtual concatenation.

6.7 Asymmetric connections

The LCAS generally assumes directional independence of individual members of a virtually concatenated group. This implies connection asymmetry, i.e. the bandwidth of the forward transport is independent of the bandwidth of the return transport. Based on this consideration, the enclosed SDL (Specification and Description Language) diagrams in Annex A, and the time sequence diagrams, in Appendix I, only consider the asymmetric connectivity.

6.8 Symmetric connection

This is for further study.

Each constituent member in the virtually concatenated group has an accompanying member in the opposite direction (similar to bi-directional), the sink side status is only reported on its partner.

If it is desired to keep the connection symmetric, this shall be provisionable from the Element Management System.

Annex A

LCAS Protocol

A.1 LCAS Protocol

The operation of LCAS is unidirectional. This means that in order to bi-directionally add or remove members the procedure has to be repeated in the opposite direction. Note that these actions are independent of each other and are therefore not required to be synchronized. The scheme allows hit-less addition and removal of bandwidth under control of a management system. Additionally, LCAS will autonomously remove failed members temporarily from the group. When the failure condition is remedied. LCAS will add the member back into the group. The removal of a member due to path layer failures will, in general, not be hit-less for the service carried over the virtual concatenated group. The autonomous addition, after a failure is repaired, is hit-less.

In this model there are three parameters to describe the virtual concatenated group of size –Xv:

1) the parameter X_{MAX}, which indicates the maximum size of the virtual concatenated group. This is usually dictated by hardware and/or standardization limits;
2) the parameter X_{PROV}, which indicates the number of provisioned members in the virtually concatenated group. Each completed ADD command will increment X_{PROV} by 1, each completed REMOVE[i] command will decrement X_{PROV} by 1. Furthermore, the relationship $0 \leq X_{PROV} \leq X_{MAX}$ holds;
3) a parameter X, which indicates the actual number of members of the virtual concatenated group as influenced by autonomous adding or deleting of members by the LCAS protocol in the case of individual member failures. The relationship $0 \leq X \leq X_{PROV} \leq X_{MAX}$ holds.

For each member (X_{MAX} times) there is a state machine at the source end that would be in one of the following five states:

1) IDLE: This member is not provisioned to participate in the concatenated group.
2) NORM: This member is provisioned to participate in the concatenated group and has a good path to the sink end.
3) DNU: This member is provisioned to participate in the concatenated group and has a failed path to the sink end.
4) ADD: This member is in the process of being added to the concatenated group.
5) REMOVE: This member is in the process of being deleted from the concatenated group.

For each member (X_{MAX} times) there is a state machine at the sink end that can be in one of the following three states:

1) IDLE: This member is not provisioned to participate in the VCG.
2) OK: The incoming signal for this member experiences no failure condition (e.g. aTSF, aTSD, or dLOM) or has received and acknowledged a request for addition of this member.
3) FAIL: The incoming signal for this member experiences some failure condition or an incoming request for removal of a member has been received and acknowledged.

These state machines run concurrently for all X_{MAX} source and sink functions. The dependencies between the state machines are described by a number of global variables for the entire group at the source end EOS is highest current sequence number (i.e. it is equal to X).

To indicate in the SDL descriptions the possible events, the following notational conventions are used:

- The following 5 control messages will be forwarded from the source end towards the sink end. A member will always forward one of these messages (so there are always X_{MAX}

messages transmitted). The messages pertain to the member from which the message is sent.

1) F_{IDLE} = Indication that this container is currently no member of the group and no ADD requests are pending,
2) F_{ADD} = Request to add this member to the group,
3) F_{DNU} = Request to delete this member from the group,
4) F_{EOS} = Indication that this member has the highest sequence number in the group,
5) F_{NORM} = Indication that this member is normal part of the group and does not have the highest sequence number.

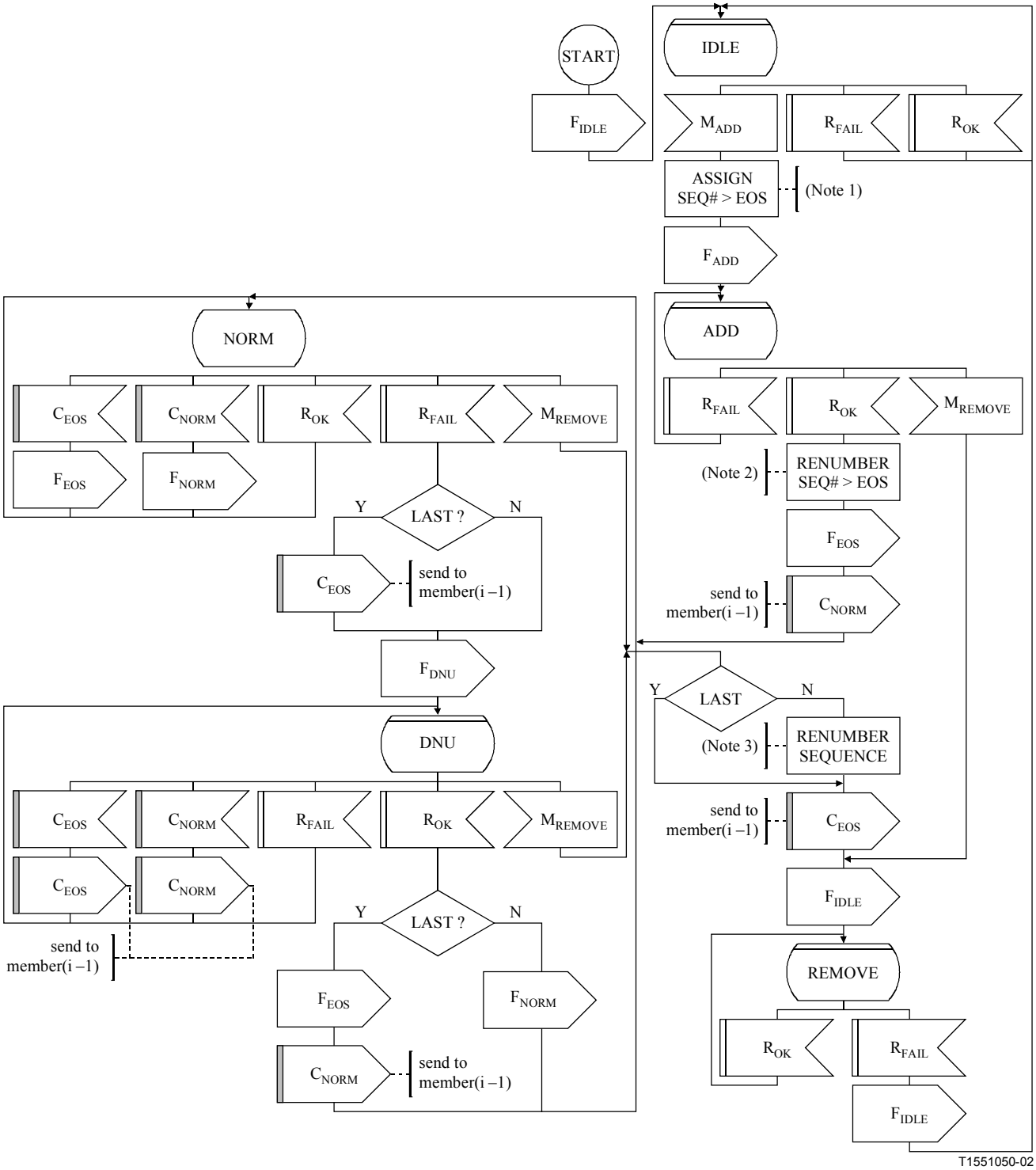
- C_{EOS} and C_{NORM} are messages (source side only) from member(i) to member(i –1), the previous in the sequence, to indicate that the control word sent by member(i –1) shall be changed as requested.
- R_{FAIL} and R_{OK} are messages from sink to source about the status of the sink end of all members. The statuses of all sink ends are returned to the source end in the control packets of each member. The source end can for example, read the information from member No. 1 and, if that is unavailable, the same information from member No. 2, etc. As long as no return bandwidth is available, the source end will use the last received valid status.
- M_{ADD} and M_{REMOVE} are message from the management system to add or remove a member. The remove operation affects a specific member. Adding a new member is always at the end of the group with a new, highest, sequence number.
- R_{RS_ACK} is a bit used to acknowledge the detection at the sink side of a renumbering of the sequence or a change in the number of members of the VCG. This acknowledge is used to synchronize source and sink and to eliminate the influence of network delays. Due to the renumbering of the sequence at the time of an add or remove request the received member status cannot be used for a time period that is determined by transmission delays and framing delays.

The LCAS protocol is described in SDL diagrams to detail the state transitions.

To avoid possible misalignment between So and Sk regarding the sequence numbers and the corresponding received far-end statuses, the number of members in the VCG is only changed under management command.

The sequence number received just before an TSF will be used for the reporting of the member status, but the payload will not be used to reconstruct the original signal. If the failed member is removed (by manager action) there will be a renumbering of the remaining sequence numbers. Replacement of a failed member (in the state DNU) because the failure in the Network cannot be repaired has to be performed via a REMOVE – ADD sequence.

A.2 State diagram of member(i) in the Virtual Concatenated Group



NOTE 1 – The SQ of the member to be added shall be set to a value greater than the SQ value of the member sending F_{EOS}.

NOTE 2 – The SQ of the added member shall be set to n + 1 if the SQ of the member sending F_{EOS} equals n.

NOTE 3 – The SQ of the removed member x ($0 \leq x < n$) shall be set to n if the SQ of the member sending F_{EOS} equals n and the SQ of members with numbers x + 1, ... n will be renumbered to x, ... n –1.

Figure A.1/G.7042/Y.1305 – Source side state diagram

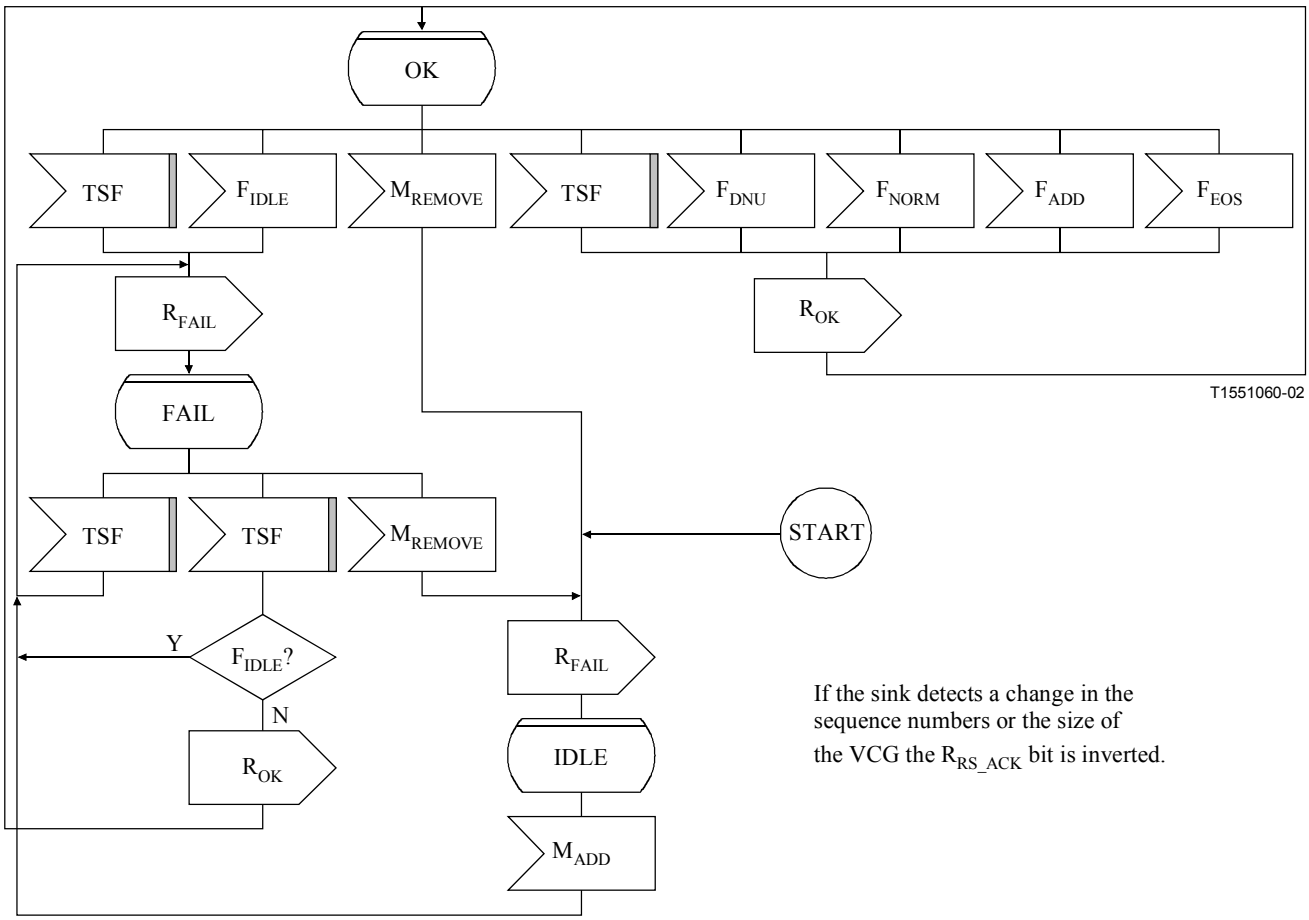


Figure A.2/G.7042/Y.1305 – Sink side state diagram

Appendix I

LCAS Time Sequence Diagrams

I.1 Nomenclature

Cmnd Command

Cnfm Confirm

Dec Decrease

LCASC Link Capacity Adjustment Scheme Controller

NMS Network Management System

Req Request

I.2 Numbering System

Members in a virtually concatenated group shall be numbered 0 to n –1, where n = total number of members in the group.

I.3 Provisioning

When a new container is provisioned to be a member of the group it must be allocated the following:

a) CTRL = IDLE (this code indicates that it is not yet in service).

b) SQ = Since at the time of provisioning it is not known in which position in the group this member will be utilized the SQ is unimportant. The SQ shall not be interpreted while CTRL = Idle (not yet in service). It could be all ONEs.

c) GID = The group ID for that virtually concatenated group.

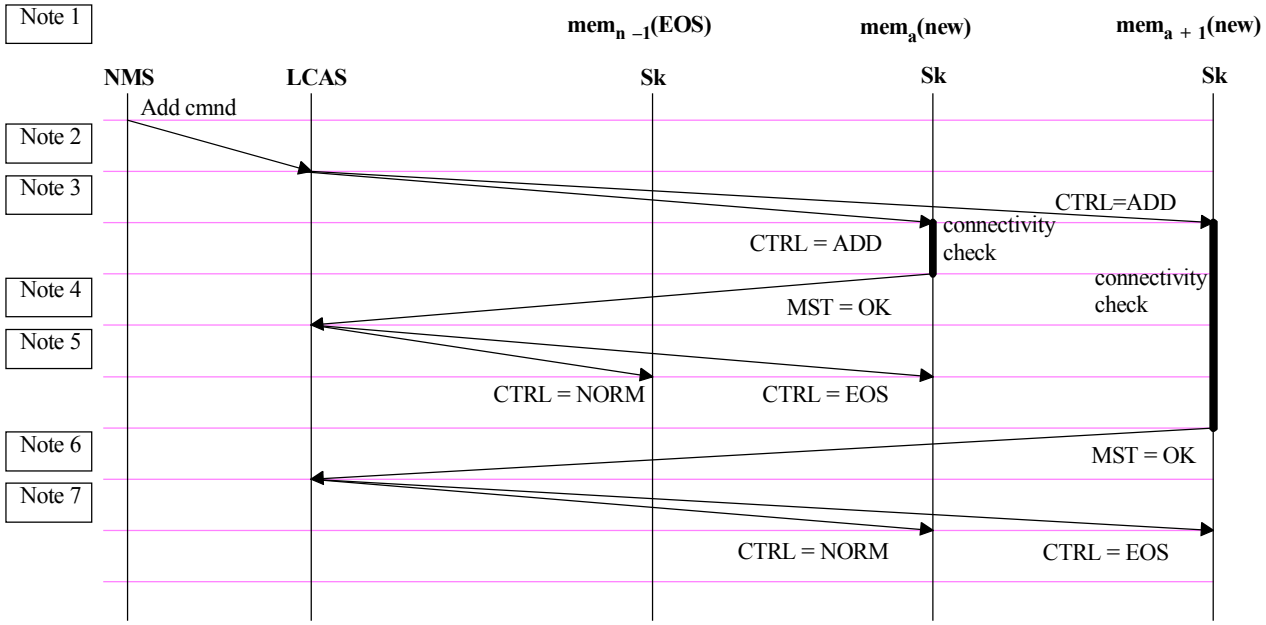
d) MST = 1 (FAIL = 1; OK = 0).

I.4 Commands

I.4.1 Increase bandwidth of VCG (ADD command)

I.4.1.1 Add (ADD) Multiple After last member

Example: Add two members after last one in the group of n.



Note		member n			member a (new)			member a + 1 (new)		
		CTRL	**SQ**	**MST**	**CTRL**	**SQ**	**MST**	**CTRL**	**SQ**	**MST**
1	Initial Condition	EOS	n –1	OK	IDLE	>n –1	FAIL	IDLE	>n –1	FAIL
2	NMS issues Add Cmnd to LCASC	EOS	n –1	OK	IDLE	>n –1	FAIL	IDLE	>n –1	FAIL
3	So (a) sends CTRL = ADD and SQ = n, So (a + 1) sends CTRL = ADD and SQ = n + 1	EOS	n –1	OK	ADD	n	FAIL	ADD	n + 1	FAIL
4	Sk (a) sends MS = OK to So	EOS	n –1	OK	ADD	n	OK	ADD	n + 1	FAIL
5	So (n –1) sends CTRL = NORM; So (a) sends CTRL = EOS and SQ = n	NORM	n –1	OK	EOS	n	OK	ADD	n + 1	FAIL
6	Sk (a + 1) sends MST = OK to So	NORM	n –1	OK	EOS	n	OK	ADD	n + 1	OK
7	So (a) sends CTRL = NORM; So (a + 1) sends CTRL = EOS	NORM	n –1	OK	NORM	n	OK	EOS	n + 1	OK

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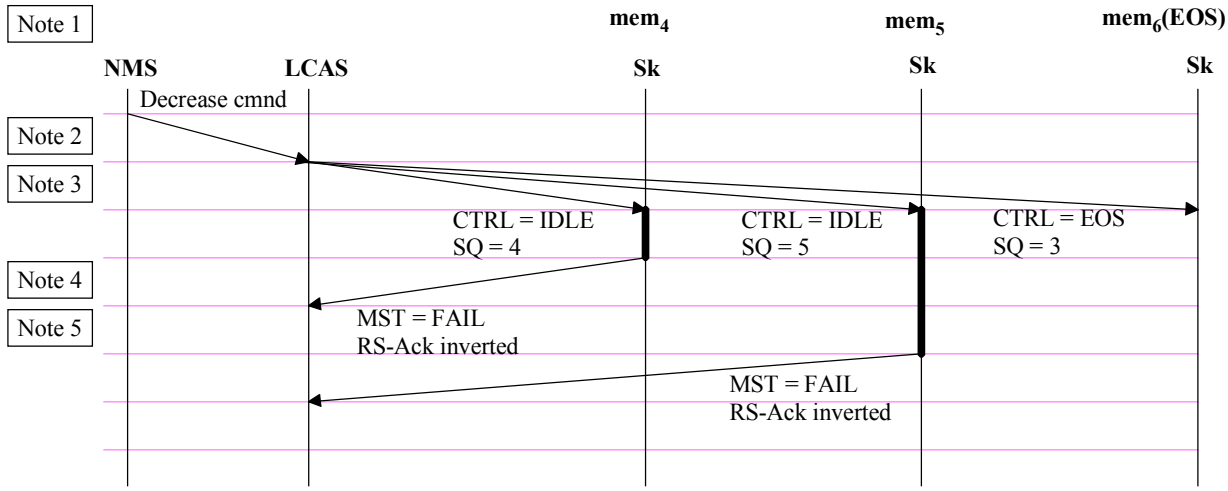
Figure I.1/G.7042/Y.1305 – ADD multiple members

NOTE – The time sequence diagram above shows an example of adding two members after the current last member. The example shows new member (a) responding with MST = OK before new member (a + 1). This is arbitrary and the first member to respond with MST = OK shall be allocated the SQ = n, then the next new member to respond with MST = OK shall be allocated SQ = n + 1 etc. If for any reason a member being added does not respond with MST = OK within the time-out period then the LCASC shall report a fail for that member.

I.4.2 Decrease bandwidth of VCG (REMOVE command)

I.4.2.1 Decrease (REMOVE) planned multiple NOT including last member

Example: Remove members 4 and 5 from a VGC with n = 6 members.



Note		member 4			member 5			member 6		
		CTRL	SQ	MST	CTRL	SQ	MST	CTRL	SQ	MST
1	Initial Condition	NORM	3	OK	NORM	4	OK	EOS	5	OK
2	NMS issues Dec Cmnd to LCASC	NORM	3	OK	NORM	4	OK	EOS	5	OK
3	So (3) sends CTRL = IDLE, SQ = 4 So (4) sends CTRL = IDLE, SQ = 5 So (5) sends SQ = 3	IDLE	4	OK	IDLE	5	OK	EOS	5	OK
4	Sk (un-wanted) sends MST = FAIL to So, and RS-Ack bit inverted	IDLE	4	FAIL	IDLE	5	OK	EOS	3	OK
5	Sk (un-wanted) sends MST = FAIL to So, and RS-Ack bit inverted	IDLE	4	FAIL	IDLE	5	FAIL	EOS	3	OK

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Figure I.2/G.7042/Y.1305 – Planned removal of members 4 and 5 out of 6

Source sets CTRL = IDLE on all members to be removed.

NOTE – CTRL does not change on the other members of the group.

The example above shows two members being removed with a simultaneous IDLE command from the LCASC (Source). Reassembly at the sink ceases to use the 'removed' members immediately upon receipt of the IDLE command.

The response, however, from the Sink may not be simultaneous. This does not affect the Sink since the IDLE commands will have the same Frame No. The response from the Sink to the Source is, of course, simply acknowledgement that the member is no longer in use at the sink end and the NMS may proceed with de-provisioning of that member, if desired.

No de-provisioning is described in the above TSD.

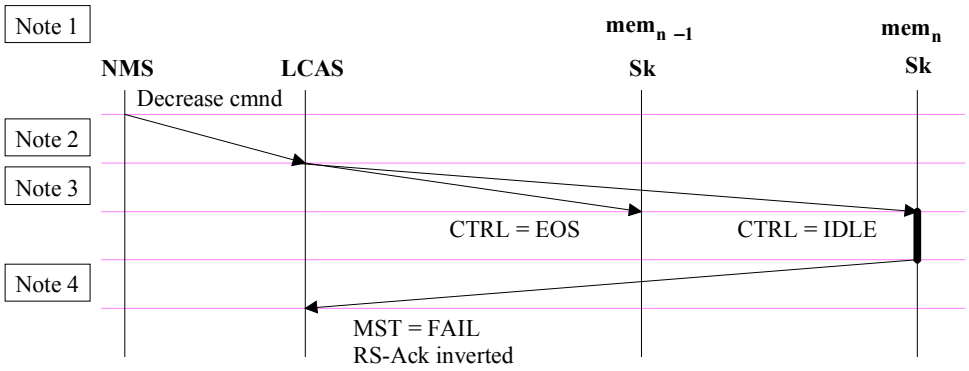
General Rule for SQ adjustment in REM function:

1) All unwanted members are re-allocated a SQ greater than the SQ of the member sending the EOS control word.

2) All remaining required members are re-allocated consecutive SQs below the un-required members (U). This is best described by the following example:

	VC	A	B	C	D	E	F	G
Before	SQ	0	1	2	3	4	5	6
				U	U			U
After	SQ	0	1	4	5	2	3	6

I.4.2.2 Decrease (REMOVE) Planned Single Last member



Note		member n –1			member n		
		CTRL	SQ	MST	CTRL	SQ	MST
1	Initial Condition	NORM	n –2	OK	EOS	n –1	OK
2	NMS issues Dec Cmnd to LCASC	NORM	n –2	OK	EOS	n –1	OK
3	So (un-wanted) sends CTRL = IDLE, SQ = n –1, So (n –2) sends CTRL = EOS	EOS	n –2	OK	IDLE	n –1	OK
4	Sk (un-wanted) sends MTS = FAIL, and RS-Ack bit inverted to So	EOS	n –2	OK	IDLE	n –1	FAIL

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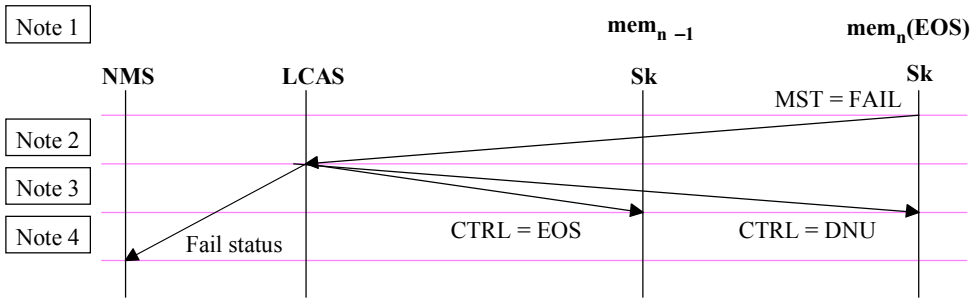
Figure I.3/G.7042/Y.1305 – Planned decrease single (last) member

NOTE – The description does not include what action to be taken beyond this point. For example, the removed member could be deprovisioned.

I.4.3 Decrease bandwidth of VCG due to fault (DNU command)

I.4.3.1 Decrease (DNU) due to fault single last member



Note		member n –1			member n (EOS)		
		CTRL	SQ	MST	CTRL	SQ	MST
1	Initial Condition	NORM	n –2	OK	EOS	n –1	OK
2	Sk (fault_mem) sends MST = FAIL to So	NORM	n –2	OK	EOS	n –1	FAIL
3	So (fault_mem) sends DNU; So (fault_mem n –1) sends EOS	EOS	n –2	OK	DNU	n –1	FAIL
4	LCASC sends Fail status to NMS	EOS	n –2	OK	DNU	n –1	FAIL

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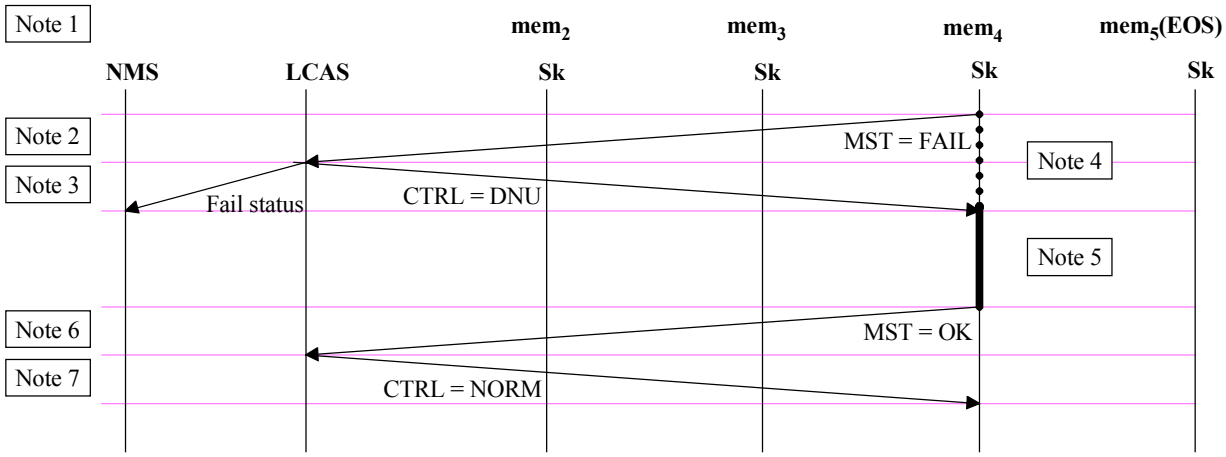
Figure I.4/G.7042/Y.1305 – Decrease due to network fault, single (last) member

Source sets CTRL = DNU on faulty member, and sets CTRL = EOS on preceding member.

I.4.3.2 Decrease (DNU) due to fault NOT last member



Note		member 2			member 3			member 4			member 5 (EOS)		
		CTRL	SQ	MST	CTRL	SQ	MST	CTRL	SQ	MST	CTRL	SQ	MST
1	Initial Condition	NORM	1	OK	NORM	2	OK	NORM	3	OK	EOS	4	OK
2	Sk (fault mem) send MST = FAIL to So	NORM	1	OK	NORM	2	OK	NORM	3	FAIL	EOS	4	OK
3	So (fault mem) send CTRL = DNU	NORM	1	OK	NORM	2	OK	DNU	3	FAIL	EOS	4	OK
4	*	NORM	1	OK	NORM	2	OK	DNU	3	FAIL	EOS	4	OK
5	**	NORM	1	OK	NORM	2	OK	DNU	3	FAIL	EOS	4	OK
6	Network Fault cleared MST = OK sent to So	NORM	1	OK	NORM	2	OK	DNU	3	OK	EOS	4	OK
7	CTRL changed from DNU to NORM ***	NORM	1	OK	NORM	2	OK	NORM	3	OK	EOS	4	OK

* As soon as the fail is detected the sink will immediately begin re-assembly of the concatenated group using only the NORM and EOS members. For a time (propagation time from Sk to So + re-action time of the So + propagation time from So to Sk) the re-assembled data will be erroneous because it is sent on all members as per pre-fault.

** However, the source will stop sending data on the erroneous members (since they will have been reported back as MST = Fail and consequently set the failed member to DNU), and send data only on the remaining NORM and EOS members. The LCASC at the receiving end does not know when the data integrity has been re-established. This is dealt with at the data layer.

*** When the failed member is repaired, the CTRL is changed to NORM from DNU. The sink will then use this member again to re-assemble the data.

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Figure I.5/G.7042/Y.1305 – Decrease due to network fault, single (not last) member

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